INSTRUCTION SHEET 5-1

UNIT 5: T-34 WIND ANALYSIS, GROUND SPEED/GROUND TRACK COMPENSATIONS, TIME AND COURSE CORRECTIONS, TURNPOINT PROCEDURES AND COMMUNICATIONS

INTRODUCTION:

In this unit the focus switches from *mission planning* to *mission execution.* If all of our computed headings were perfectly accurate, if there was no crew error of heading or airspeed, and if there was no wind in the low level environment, the mission could be flown exactly as planned without in flight adjustment. Unfortunately, it just doesn't work that way! Even without wind effects, various other errors combine to put us off course and off planned time. Your job is to compensate for winds and counter errors so that the aircraft and/or weapons get to the right place at the right time!

In addition to computing winds, compensations and corrections, this unit covers the crew coordination and communications required for effective mission execution. This unit teaches the standard procedures and techniques for basic visual low level navigation.

ENABLING OBJECTIVES:

2-3 Maintain or make recommendations to maintain a visual low-level course, given a specified course ± 2 nm.

2-5 Recommend airspeed adjustments to arrive on target on time (± 1 minute) on a visual low-level course, given a target time and a specified course.

2-6 Adjust or make recommendations to preflight planned headings and airspeeds to compensate for the effects of wind, given a target time and a specified course, within ± 2º and ± 5kts. of instructor's computations.

2-8 Given a T-34C mission, determine wind direction and speed within ± 30º and 10 kts.

7-2 Given a mission, make recommendations to maintain proper aircraft flight parameters through the use of instrument scan; ± 5º of heading, ± 10 kts of airspeed, and ± 100 feet of altitude.

7-9 Given a mission, make appropriate VNAV turnpoint, intermediate checkpoint, and hazard calls using proper format and terminology without error.

ENABLING STEPS:

2-3-1 Using previously constructed mission materials, navigate a T-34C aircraft using basic navigation procedures and techniques.

2-5-1 Compute the correct indicated air speed to maintain 150 kts true airspeed using outside air temperature.

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2-8-1 Using preflight weather information and in-flight visual cues, recognize general wind direction and velocity.
2-8-2 Using visual references, determine aircraft position relative to course.
2-8-3 Using visual references, determine aircraft progress with respect to planned timing.
2-8-4 Apply distance off course over time flown to resolve cross wind components affecting aircraft track.
2-8-5 Apply deviations from planned timing over time flown to resolve head and tail wind components affecting aircraft timing.
2-6-1 Using resolved cross wind component, adjust or make recommendations to flight planned headings to compensate for wind effect.
2-6-2 Using resolved head/tail wind component, adjust or make recommendations to flight planned airspeed to compensate for wind effect.
2-6-3 Using compensated heading and known distance from course, compute and apply course corrections to maintain a visual low level course ± 2nm.
2-6-4 Using compensated airspeed and known deviation from planned timing, compute and apply corrections for errors in excess of 12 seconds to arrive on time at target, ± one minute.
2-6-5 Recognize deviations not corrected for and update planned ETA and course information as necessary.
7-2-1 Develop an effective scan for monitoring basic flight instruments to identify deviations from heading, altitude, or airspeed.
7-2-2 Make recommendations to correct errors of heading, airspeed, or altitude in flight.
7-9-1 State the proper format of radio calls particular to the low level environment, such as flight service and request for IFR flight following low level.
7-9-2 In order, state the items of VNAV two minute prior, mark on top, intermediate checkpoint, and wings level calls.
7-9-3 State the proper format for in-flight hazard calls for both obstruction and bird/traffic avoidance.

INFORMATION SHEET 5-1

Basic T-34 Visual Navigation

The VNAV mission planning materials are complete, but how do we use them? Fundamentally, visual navigation uses the same basic navigation skill as any other phase of flight. Turning at the right place at the right time and flying the correct altitude, heading and airspeed are essential whether you are on a departure, approach, or enroute at high or low altitudes. The main difference is in how we verify our course and mission progress. Visual references allow us to fix our position and make adjustments as necessary. But what if, for some reason, these references are unavailable? In this situation, where our planned reference is not visible, turn on the updated planned time to maintain best-known position and timing.

It is inevitable that we will get off both our planned track and our scheduled timing. It is important to realize that this is not merely the effect of winds. Measurement and representation of course, in flight heading errors, and chart errors are just some of the contributing sources for time and position error. In flight, you must identify and account for these factors when analyzing position and time with respect to winds.

One such error that affects airspeed is temperature. Visual navigation flights are planned at a specific ground speed, for most T-34C VNAV flights this is 150 Kts. If there were no winds in the low level environment, flying 150 kts. true airspeed (TAS) would accomplish this, so we start by computing the indicated airspeed required to maintain 150 kts. TAS. To accomplish this, take the current outside air temperature and apply it to the table shown on page 4-4 (figure 4-3). A copy of this table should be in your in-flight guide.

Compensating and Correcting for Wind

A primary factor affecting both your timing and course control is wind. To overcome this obstacle, any method for Visual Navigation must contain the following five steps:

FIX ANALYZE COMPENSATE CORRECT UPDATE

In the most basic sense, these steps answer the questions:

1. Where am I?
2. How did I get here?
3. How do I keep from getting further off course/time?
4. How do I get back on course/time?
5. How is my timing and course at the next point affected?

For your current experience level, it is important to perform these steps in specific order. It is also the order in which we will discuss them.

INFORMATION SHEET 5-2

Wind Analysis and Compensation

In Intermediate Phase, there are two methods of wind analysis: *visual analysis* and *track analysis*. Visual analysis gives results in the form of total wind, while track analysis gives results in terms of the headwind and crosswind components. In either case, you will need both the total wind and its components in order to make the proper compensations.

Visual Analysis

Visual analysis has the advantages of being quick and requiring few calculations, though it may be less accurate for determining wind magnitudes. The process is quite simple: observe the effects of wind on smoke, waves, trees, etc and determine the total wind from your observations.

There are several visual cues available to determine wind speed and direction. Water (waves/spray - white caps at 15 kts of wind), windsocks, and even airport traffic patterns give clues to wind direction and magnitude. Smoke, one of the easier cues, is fairly common and can serve as an excellent initial wind analysis or confirm an existing wind analysis.

Wind analysis using smoke is most effective when viewed from directly above; the further away the source of the smoke is from track, the less accurate your analysis. If your track does not take you directly over the source of smoke, make your estimations from the closest point of approach. While direction is easy to determine, it requires practice to determine wind magnitude. Typically, this is easier when the smoke has a point source, such as a smokestack. Figure 5-1 gives a rough guide for estimating wind velocity based on its angle with a vertical axis.

After computing a total wind value, break it down into crosswind and head/tail wind components. Figure 5-2 provides a basic guide for determining the wind components based on the wind direction relative to your heading. Notice that this technique is the same as that used in instrument navigation.

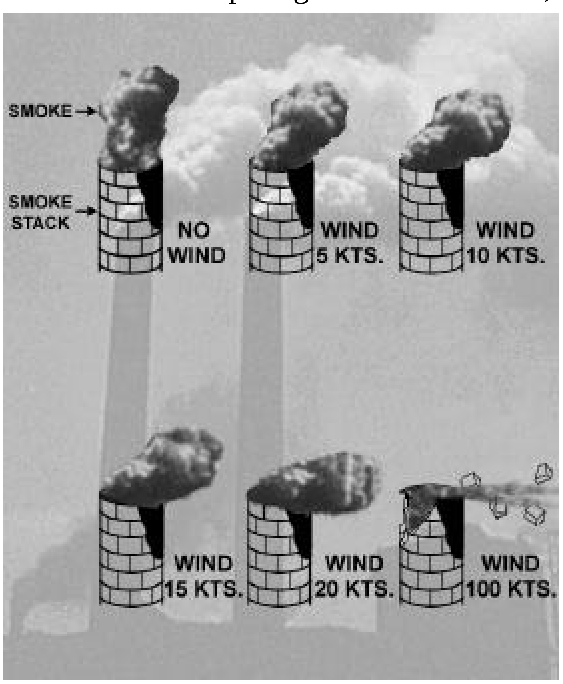

Figure 5-1

Track Analysis

Track analysis takes longer than visual analysis of winds, and requires more mental calculations. However, it is typically more accurate. Track analysis determines the wind components by analyzing time and course deviations over a known period of time.

INFORMATION SHEET 5-3

Crosswind Calculations for T-34C

Crosswind is the component of the wind that “pushes” the aircraft off course. It is nothing more than the velocity of the aircraft perpendicular to its heading. This component may be calculated using the following formula:

$$\frac{\text{Distance off course (nm)}}{\text{approx. time flown (min)}} \times \frac{60\text{ min}}{\text{hr}} = \text{Crosswind (kts)}$$

An alternative method of computing cross wind values is to convert the distance off into seconds, and apply the following equation:

$$\frac{\text{Distance converted to time (sec)}}{\text{time flown (min) since last compensation update}} \times \frac{5}{2} = \text{Crosswind (kts)}$$

For this equation, 5/2 represents your "miles-per minute." For a planned ground speed of 150 kts, this is equal to 2.5 nm. At 180 kts, this value increases to 3, and at 300 kts (T-1) the value will increase to 5. Additionally, for 150 kts 1 nm is equal to 24 seconds. For 180 kts, 1 nm equals 20 seconds.

Example: On the first leg of a low-level you acquire a road/ railroad intersection which should be 1/2 mile left of course at time 5+48. At time 5+50 the intersection passes down the right side of the aircraft at 1/2 mile. How much crosswind are you encountering assuming no prior compensations for the wind?

You are 1 NM left of course, and have been flying for about 6 minutes. Before working the numbers, realize that you have a right crosswind because you are left of course, then:

$$\frac{1\text{ nm}}{6\text{ min}} \times \frac{60\text{ min}}{\text{hr}} = 10\text{ kts } \underline{\text{right}}\text{ crosswind}$$

- OR -

$$\frac{24\text{ sec}}{6\text{ min}} \times \frac{5}{2} = 10\text{ kts } \underline{\text{right}}\text{ crosswind}$$

INFORMATION SHEET 5-4

Head / Tail Wind Component

If wind is pushing the aircraft ahead or behind preflight time, the rate of error is proportional to the head/tailwind velocity. The following formula applies:

$$\frac{\text{Time gained or lost (sec)}}{\text{approx. time flown (min) since last compensation update}} \times \frac{\text{nm}}{\text{sec}} \times \frac{\text{60 min}}{\text{hr}} = \text{Head/Tailwind (kts)}$$

The head/tail wind component affects our timing and is a result of the difference between our true airspeed and our actual ground speed, so the equation basically converts the time off to a distance, which is then divided by time flown.

For a T-34 route planned at 150 knots, 1 nm equals 24 seconds. This is the source of the second factor in the formula. Canceling terms, the simplified formula becomes:

$$\frac{\text{Time gained or lost (sec)}}{\text{approx. time flown (min) since last compensation update}} \times \frac{\text{1nm}}{\text{24sec}} \times \frac{\text{60 min}}{\text{hr}} = \text{Head/Tailwind (kts)}$$

Reducing terms:

$$\frac{\text{Time gained or lost (sec)}}{\text{approx. time flown (min) since last compensation update}} \times 2.5 \quad \text{(or 5/2)} = \text{Head/Tailwind (kts)}$$

Notice that the equation is equivalent to time off divided by time flown multiplied by the miles per minute. Therefore, for a planned ground speed of 180 kts, 3.0 would be used instead of 2.5. If planned at 300 kts ground speed, what would replace 2.5? The answer is 5, and you will fly this airspeed later in the T-1. Below is an example of head/tail wind computation:

Example: At time 11+58 you pass abeam of a road bridge, updated time 11+48. You passed the previous turnpoint at 7+46, and it had an updated time of 7+48. How much head/tailwind are you encountering?

At the last turnpoint, you were 2 seconds early, at this turnpoint you are 10 seconds late, for a difference of 12 seconds. Time flown is 11+58 - 7+46 = 4+12, approximately 4 minutes. Because we got later, we note that we have a head wind, then:

$$\frac{12 \text{ sec}}{4 \text{ min}} \times \frac{5}{2} = \frac{15 \text{ kts}}{2} = 7.5 \text{ kts } \underline{\text{headwind}}$$

Round your winds to the nearest 5 kt. increment. In this case either 5 kts or 10 kts would be acceptable. The standard is +/- 10 kts from actual wind velocity. Remember you are considering the time flown since the last fix so you must use the total difference since your last fix. If you crossed your last turnpoint 6 seconds late and then crossed a checkpoint 8 seconds late you would enter the formula using only 2 seconds and the time between the two checkpoints.

The Five Minute Rule: Crosswind

Let's take a look at some special cases of the equations discussed so far. What if the time interval flown was five minutes? First, let's look at crosswind for a speed of 150kts:

$$\frac{\text{Distance off course (nm)}}{5} \times \frac{60 \text{ min}}{1 \text{ hr}} = \text{Crosswind (kts)}$$

Reducing the terms, we find that for five minute intervals crosswind equals:

$$\text{Distance off course in miles} \quad \times \quad 12$$

For our purposes, we can use the above equation for time intervals between 4 and 6 minutes without sacrificing a significant amount of accuracy. You may want to check other intervals as well. What would the equation look like if the time interval was 6 minutes? What about 3?

The Five Minute Rule: Head/Tail Wind

Now let's look at our head/tail wind equations. For five minute intervals we have:

$$\frac{\text{Time off updated time (sec)}}{5} \times \frac{5}{2} = \text{Head/Tailwind (kts)}$$

Which becomes:

$$\text{Time off updated time (sec)} \times \frac{1}{2} = \text{Head/Tailwind (kts)}$$

For computing head/tail wind components over 4 to 6 minute intervals, simply use half of the time off in seconds. Again, it may be helpful to check other intervals as well. Remember that the five minute rules are approximations when not used at exactly five minutes.

Your results using a four or six minute interval is reasonably accurate, but requires considerably less mental math. To improve your accuracy when using these techniques, round up when using intervals closer to four minutes, and round down if closer to 6 minutes. Additionally, refine your computations as more information becomes available along the low-level route, and always round to the closest 5 kt increment.

Total Wind Computation

Once you have the wind components, determine total wind. This is necessary in order to compute the correct compensated headings and airspeeds for the two-minute prior call, and to

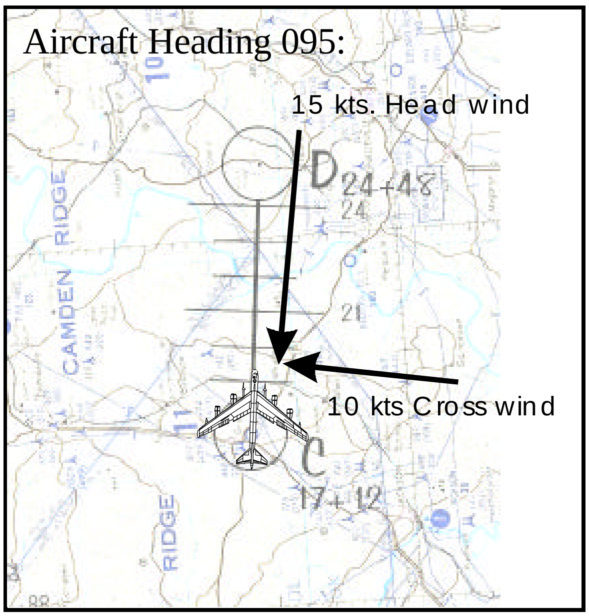

Figure 5-2

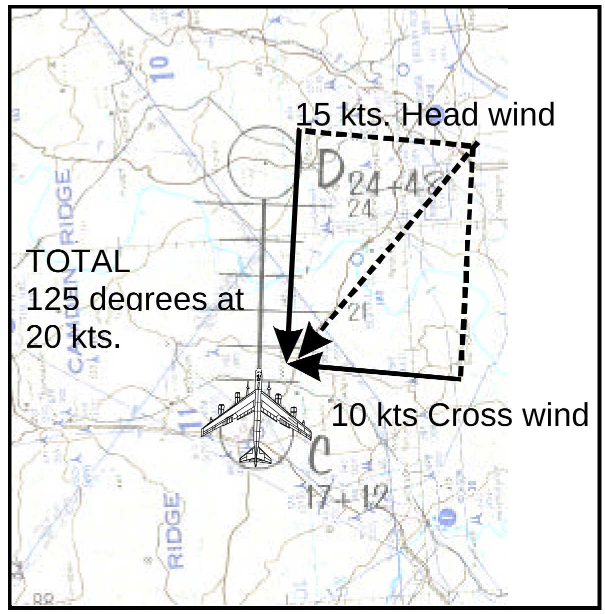

Figure 5-3

put in the appropriate adjustments to base heading and base airspeed at the beginning of subsequent legs. If we draw the separate wind components on our navigation chart, it is easier to determine the total wind and prevents gross errors.

Figure 5-2 shows a 15 kt. head wind and a 10 kt. cross wind. Notice that the lines or "vectors" are drawn to approximate the magnitude of the wind; that is, the cross wind line is 2/3 the length of the head wind (refer to figure 5-5). With our wind vectors drawn to approximate scale, determining the wind direction and magnitude is easy: simply complete the rectangle and draw a diagonal as shown in figure 5-3. The diagonal represents both the total wind direction and its magnitude.

You can also estimate total wind magnitude quickly using the same guide you used in instrument navigation.

LARGER WIND COMPONENT + 1/2 SMALLER WIND COMPONENT = TOTAL WIND

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You can use this method even when the two components are equal, and you must still estimate the direction of the total wind from the relative magnitudes of its components. With practice your estimate will be within 10º of the actual wind (The standard is +/- 30º). The wind component chart in figure 5-5 can be helpful in determining both wind components and total wind vectors.

Once we have determined our wind direction and velocity, it is a good technique to create a picture of it by visualizing the wind on the HSI. This can prevent gross errors in compensations (crabbing the wrong way). The techniques used in figures 5-2 and 5-3 combined with the HSI gives us another technique for determining wind components. If the total wind is known and "placed" on the HSI, one can estimate the magnitudes of the components by estimating the relative lengths of the horizontal and vertical axis. Figure 5-4 shows a wind of 210 degrees and 20 kts (dashed line) on the HSI and the breakdown of the wind components. The outside of the HSI is equal to the total wind velocity.

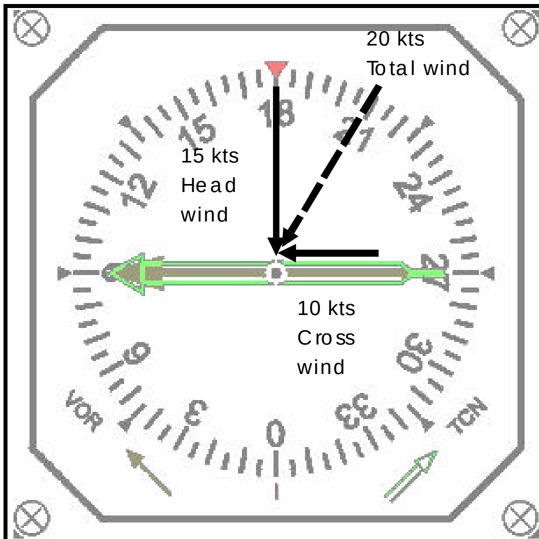


Figure 5-4

Another technique is to draw (in black ink) a wind "T" to help visualize the wind vector. This is merely a cross drawn on your chart, oriented with the MC for the leg drawn, and annotated accordingly. As with any annotation, be sure that it falls outside of 3nm of the course line. Figure 5-4A is an example of a wind "T." In flight, this provides a convenient place to write and compute wind information.

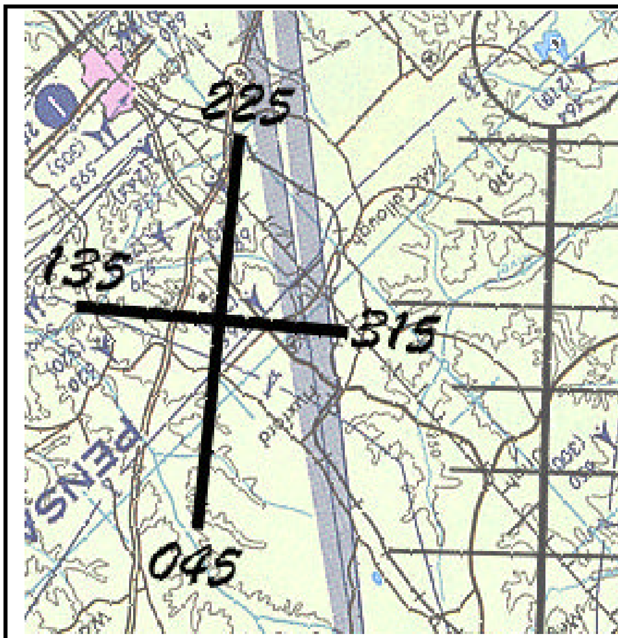
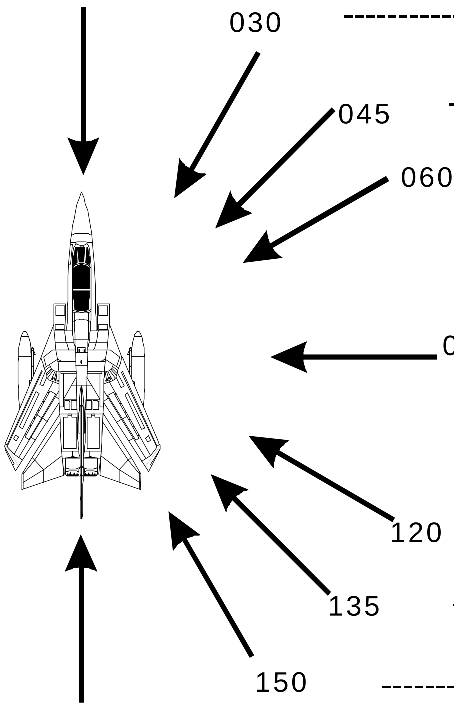


Figure 5-4A

INSTRUCTION SHEET 5-8

WIND COMPONENT BREAKDOWN



	HEAD/TAIL WIND	CROSSWIND
360	ADD FULL WIND	ZERO
030	ADD 3/4 OF WIND	1/2 OF WIND
045	ADD 2/3 OF WIND	2/3 OF WIND
060	ADD 1/2 OF WIND	3/4 OF WIND
090	ZERO	FULL WIND
120	SUBTRACT 1/2 OF WIND	3/4 OF WIND
135	SUBTRACT 2/3 OF WIND	2/3 OF WIND
150	SUBTRACT 3/4 OF WIND	1/2 OF WIND
180	SUBTRACT FULL WIND	ZERO

FOR T-34 VNAV, USE 2º CRAB FOR EACH 5 KTS OF CROSSWIND.

Figure 5-5

COMPENSATING FOR WIND

The **F**ix enabled you to **A**nalyze the winds, now you need to **C**ompensate for their effect on the course and mission timing.

Calculate crab just as you did in instrument navigation. At 150 kts, crab 2º for each 5 kts of crosswind. Round wind values to the nearest 5 kts, so that your adjustments to base heading are always in 2º increments.

You will also have to adjust for the head/tailwind. Make adjustments to your base airspeed (the indicated airspeed you calculated to fly 150 KTAS, see figure 5-6) in 5 kt increments for the head/tailwind you encounter.

INSTRUCTION SHEET 5-9

T-34C AIRSPEED/TEMPERATURE CHART (150 TAS)

TEMPERATURE RANGE	IAS
+49ºC and higher	140 IAS
+11°C to +48ºC	145 IAS
-9ºC to +10ºC	150 IAS
-29ºC to -10ºC	155 IAS

Figure 5-6

Example: Your aircraft is on a base heading of 072°, base airspeed is 145 KIAS for 150 KTAS. At time 4+30 the aircraft passes 1/2 NM right of a checkpoint which you preflighted/updated to be on course at time 4+06. Estimate the wind and the appropriate compensations.

Using the 5 minute rule: 1/2 nm X 12 = 6 kts <u>left</u> crosswind

$\frac{\text{24 sec late}}{2}$ = 12 kts headwind

Total wind = 12 kts + (1/2 X 6 kts) = 15 kts total wind

Figure 5-7 shows the winds drawn on a wind T. The HSI could also be used, but what is important is to realize that the wind is more of a headwind than a crosswind, and that the result should be near the 10 to 11 clock position.

Now for the compensations:

Because our time interval was less than 5 minutes, we will round the headwind component up to 15 kts. Since the crosswind was computed at 6 kts, it is best to round this to 5 kts.

Headwind compensations are easy: We simply add the headwind to our current base indicated airspeed, and tell the pilot to fly 160 kts. IAS. If the component was a tailwind, we would have subtracted 15 kts.

Crosswind compensations are also simple. For each 5kts. of crosswind, crab 2° . In this example, we would tell the pilot to "Turn <u>left</u> 070°".

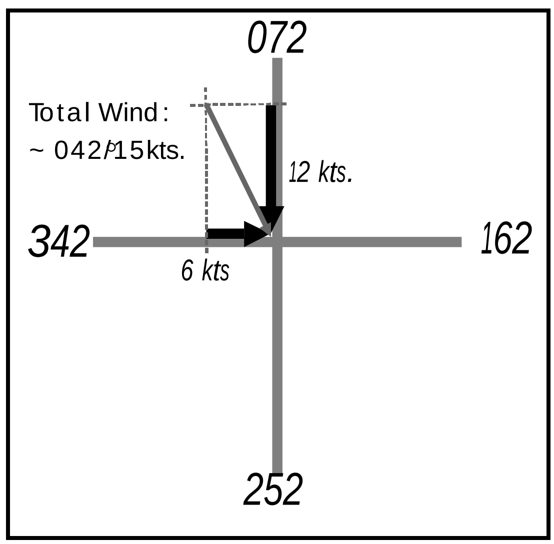


Figure 5-7

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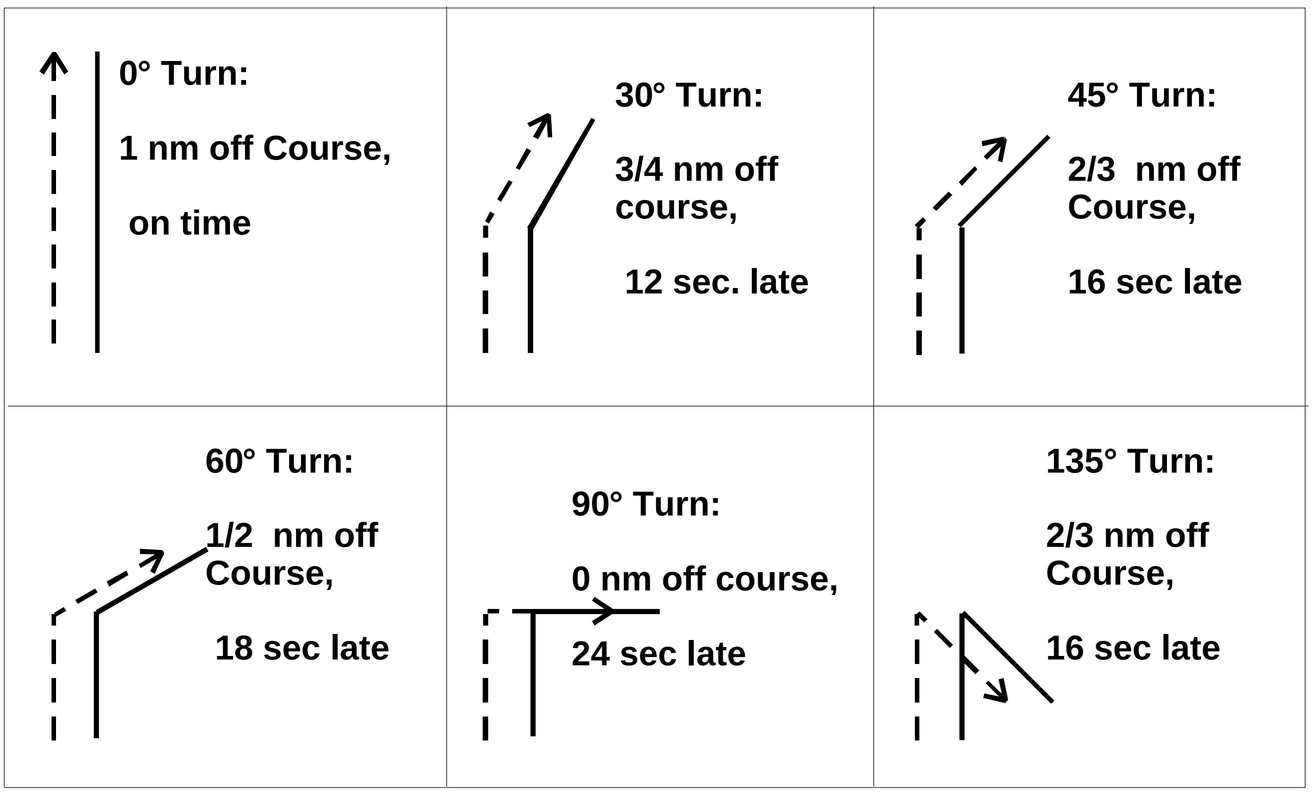
The compensations remain valid until you change course or get new information about the wind.

When using track analysis remember not *all* course and time deviations are due to wind. Always apply logic and common sense in your wind analysis. Temperature changes as you proceed inland and cross weather system boundaries. As this affects airspeed, you may incorrectly perceive the change as a wind effect. This perceived head/tail wind will seem to follow the aircraft regardless of heading change. Additional errors can be due to preflight heading or the chart itself.

Turns also can change course error into time errors, and vice versa. Figures 5-8 and 5-9 illustrate relationships for different turn magnitudes. Though not carried in flight, students must apply the information in figures 5-8 and 5-9 as necessary during turn point calculations.

Affect of Turn on Course and Timing



Initial conditions: On time, 1nm left of course. Dashed line represents aircraft actual flight path.

Figure 5-8

ADDITIONAL TURNPOINT ANALYSIS FOR T-34C

DIST ABEAM BEFORE TURN	DEGREES OF TURN	TIME OFF (SEC)	DIST ABEAM
1 NM	0°	0	1 NM
1 NM	30°	12	3/4 NM
1 NM	45°	16	2/3 NM
1 NM	60°	18	1/2 NM
1 NM	90°	24	0 NM
1 NM	120°	18	1/2 NM (OPP SIDE)
1 NM	135°	16	2/3 NM (OPP SIDE)
1 NM	150°	12	3/4 NM (OPP SIDE)
1 NM	180°	0	1 NM (OPP SIDE)

Above are further calculations of the effect of turns on existing time and course errors.

Figure 5-9

CORRECTIONS

The **F**ix told us where we where, **A**nalysis told us why, **C**ompensations stopped us from getting further off time or course, and now a Correction is needed to put us back on planned time and track. In making corrections, it is important to remember the following:

- Corrections for time and course can usually occur simultaneously.
- Standard course corrections are done for ½ nm errors or greater.
- Standard time corrections are done for 12 sec or more off of *flight planned timing*.

Both timing and course deviations are critical. However, because course errors have a significant effect on the ability to identify check points, course maintenance has an increased priority in low level navigation.

CORRECTIONS FOR COURSE

There are several approved methods for course correction during the intermediate phase of your training. They are as follows:

- Standard Corrections - When the distance from track is known.
- BDHI Corrections - When the distance from track is unknown or estimated less than ½ nm from track.
- "Jungle Rules" or "Non-standard" corrections, which are used only on the target leg with the target in sight.

STANDARD CORRECTIONS

The table below (Figure 5-10) summarizes the standard course corrections for VT-4/10. These simplified corrections are approximate and only apply for aircraft at 150 kts. Notice that corrections larger than 30° are not allowed. This is due to the effect it would have on course timing and that the turns from and to desired track would induce additional course error.

STANDARD CORRECTIONS FOR 150 KTS GROUND SPEED

DISTANCE OFF COURSE	CORRECTION		TIME(min)
1/2 mile	10°	for	1+00
1 mile	10°	for	2+00
OR	20°	for	1+00
1.5 miles	10°	for	3+00
OR	30°	for	1+00
2 miles	10°	for	4+00
OR	20°	for	2+00
3 miles	10°	for	6+00
OR	20°	for	3+00
OR	30°	for	2+00

Figure 5-10

Example: After a fix, analysis, and compensation, the aircraft is 1½ nm right of track. Compensated heading is 053° , and current time is 15+24. Call for the correction in the following manner: "Pilot, Left 043. Time in 15+24, time out 18+24." A technique is to then annotate your chart with mark on the course line one mile past the 18 minute tick mark (18+24). This serves as a memory jogger to take the correction out at the appropriate time.

From figure 5-10 note that all standard corrections are in 10, 20, or 30 degree heading changes (*to compensated heading*) and for increments of 1 minute. For example, a 20° correction for 1+30 to correct for 1½ nm is not permitted in this stage of training. An acceptable correction would be 10° for 3 minutes or 30° for 1 minute.

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While the amount of time is always in multiples of 1 minute, if a subsequent checkpoint shows the aircraft back on track prior to the correction being completed, terminate the correction. Using the previous example, if at 17+00 the aircraft is nearly on course (determined from an intermediate checkpoint), the correction might terminate as follows: "I fix our position nearly on course; Pilot Right 053° ." Likewise, if at 17+00 the aircraft is still 1nm right of track, update the correction for one additional mile. This extension might sound as follows "At time 17+00 I fixed our position one mile right of track, time out for course correction is now 19+00."

Example: Preflight course is 355° . Compensated heading 359° . At time 6+24 you fly 1/2nm right of a bridge preflighted to be 2½ nm left of course. Assuming compensations have already been applied, what standard corrections can be made at 6+40 to get back on course?

If the above description is difficult to visualize, draw it out! Resolving the above information, the aircraft is 2 nm left of planned course. With a time in of 6+40, options are as follows:

- "Right 009, time in 6+40, time out 10+40."
- "Right 019, time in 6+40, time out 8+40"

BDHI CORRECTIONS

Situation: The next turn point (a large lock and dam) is visible two minutes prior to the turn. Unfortunately, instead of being at the 12 o'clock position, it is about 10 degrees right of the nose. From this it is obvious that the aircraft is not on course, but it is not known just how far off course the aircraft is.

This is the situation where BDHI corrections are most helpful. The goal of this maneuver is to intercept the flight planned course inbound to the check point. It is NOT a homing maneuver to the point! This is similar to intercepting and maintaining a radial to a navaid, only the navaid is a visual check point and the radial is our flight planned magnetic course (hence the term "BDHI correction").

To perform a BDHI Correction, the following conditions must exist:

- The checkpoint must be on or closer to course than the aircraft. It may not be on the opposite side of planned track.
- The checkpoint must be in sight and within 30 degrees of compensated heading (11 to 1 o'clock).
- The aircraft is an unknown distance from planned course (otherwise perform a standard correction.)

BDHI corrections follow this basic format:

- Call for a 30° turn from *compensated* heading towards the checkpoint.
- As the aircraft turns to the new heading, the point will drift to the opposite side of the 12 o'clock position. Call "steady up" after this occurs.

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- Using the HSI, estimate when a turn back to planned course will cause the point to move to 12 o'clock. (Visualize the check point on your course line.)
- Lead the turn back to course as necessary, so that when the maneuver is complete you are on compensated heading with the point at 12 o'clock.

The following examples demonstrate the BDHI maneuver and common errors associated with it:

BDHI Example 1: The check point (a tower) is visible on the horizon, but is 5 to 10 degrees left of the nose. The tower is on planned course, within 30 degrees of our compensated heading (180°), and we are an unknown distance from course. These are the conditions presented in figure 5-11.

The first step is to call for a 30° turn to the *left.* It is not always necessary to allow the aircraft to turn the full 30°, but the initial call is always for the full 30°-- have the pilot "steady up" after the tower has "moved" to the opposite side of the nose, as in figure 5-12. The call for this turn might sound as follows: "Checkpoint in sight, Pilot left 150° for BDHI… <Clear> " as the point passes the opposite side of the 12 o'clock position, "Pilot, steady up."

Checkpoint in sight, within 30° of compensated heading, aircraft is unknown distance off course.

Figure 5-11

The pilot stops the turn on the "steady up" call after 20° of turn. The aircraft is now heading towards the flight planned course. As the aircraft gets closer to the tower (and planned course), the tower's position will drift to the right. In this example, the aircraft rolled out on a heading of 160°, as only 20° of heading change put the tower 10° right of the nose. (Figure 5-12)

Checkpoint ~10° right of the nose, aircraft proceeding back towards course. Tower will "drift" to the right.

Figure 5-12

INSTRUCTION SHEET 5-15

If the current heading is 160°, then when the tower is 20° to the right of the nose (180°, almost 1 o'clock to our current heading), the aircraft is on course. Ideally, the tower will be at 12 o'clock when the aircraft returns to a heading 180°. However, the turn back to compensated heading should be led, just as one would lead a turn on to a radial. Figure 5-13 shows the conditions prior to the turn back to course: "<Clear right> Right 180°." In each of these steps, do not forget to clear the aircraft!

Checkpoint approaching 20° mark, aircraft approaching course.

Figure 5-13

Figure 5-14 shows the BDHI maneuver correctly completed. Note that the aircraft is back on course prior to the checkpoint. If the tower is a turn point, it is critical that the aircraft is on heading prior to the tower. Being off heading prior to the turn affects the final position of the aircraft on roll out; these errors increase at faster speeds and extreme turns typical of tactical aircraft.

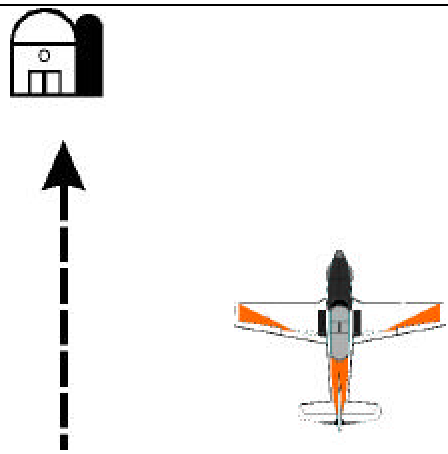
Checkpoint at 12 o'clock, aircraft on 180° course.

Figure 5-14

INSTRUCTION SHEET 5-16

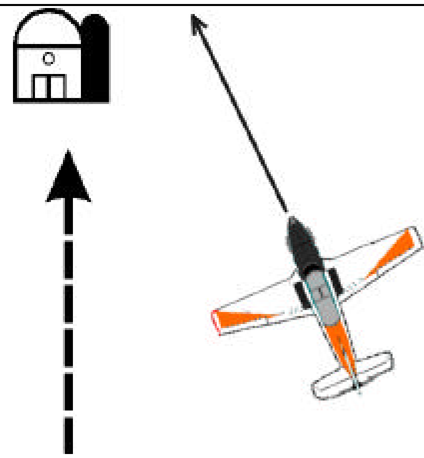
BDHI Example 2: The checkpoint (a silo) is visible on the horizon; the silo is on planned course, and our compensated heading is (180°). We are an unknown distance from course. These are the conditions presented in figure 5-15.

As in the previous example, a turn is initiated to the left, heading 150°. However, in this example, the silo never crosses the 12 o'clock position. This is illustrated in figure 5-16.



Heading 180°, check point in sight, unknown distance off course.

Figure 5-15



Heading 150°, check point still left of the 12 o'clock position.

Figure 5-16

The BDHI maneuver is not going to work in this situation; the silo was not within 30° of the compensated heading. The best course of action is to return to compensated heading, mark abeam of the checkpoint (noting the distance abeam), and perform a standard correction. This is depicted in figure 5-17.

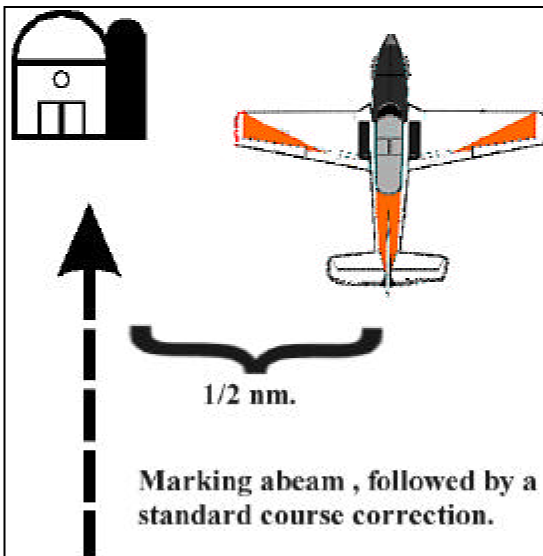


Figure 5-17

INSTRUCTION SHEET 5-17

In summary, for the BDHI correction the checkpoint must be within 30°of the nose (11 to 1 o'clock), the point must be on or closer to course than the aircraft (but not over the course line), and the aircraft is an unknown distance from course.

“JUNGLE RULES”

Use “Jungle Rules” or “Non-standard” corrections on the target leg with the target in sight. For course corrections to the target, turn the aircraft in the direction of the target, and call for roll out as the target approaches the 12 o'clock position. This maneuver might sound as follows: "Target in sight, at 2 o'clock, hard right, clear right." As the target approaches twelve o'clock: "Steady up, target at 12 o'clock." In this situation, it is not necessary to cross the target on flight planned heading. However, if using a BDHI, command a turn back to the compensated heading prior to reaching the turn point to avoid turning inside or outside the outbound course.

The priorities for marking on top the turn point are (target not included):

1. On course, on heading.

2. On heading, abeam.

3. Turning on the updated time (turn point not in sight).

CORRECTIONS FOR TIME

In the T-34 use a 15 knot speed change (10% of your base ground speed) to correct timing deviations. At 150 kts ground speed, a 15 knot change (10%) will add or reduce six seconds each minute. This equates to one second of change for every 10 seconds the correction is in effect. As a result, any time correction you initiate will be a *multiple of 10 seconds*.

Timing Example 1:
FIX:
You cross a highway perpendicular to your course at time 9+38, and preflight was 9+24. You were on time at your last checkpoint, 4+36. Base airspeed compensated for temperature) is 145 KIAS. What compensation and corrections should you apply?

ANALYZE:

Preflight: 9+24	Actual: 9+38	14 seconds late

Time flown = 9+38 - 4+36 = 5+02

Using the 5 minute rule, 14 seconds over 5 minutes means 7 knots headwind (round to 10 kts.).

INFORMATION SHEET 5-18

COMPENSATE:
"I estimate 10 knots headwind. Compensated airspeed is 155 KIAS (145 + 10)."

CORRECT:
To correct for 14 seconds adjust speed 15 knots for 140 seconds (2 minutes 20 seconds).

"Airspeed 170 KIAS for 2 minutes 20 seconds. Time in: 10+10. Time out: 12+30."

The following notes also apply to time corrections:

1. The time it takes for the aircraft to accelerate to the correction airspeed and the time to decelerate afterwards cancel each other. Timing starts when the pilot first advances/retards the throttle and ends when the throttle is moved back.

2. Only 15 knot changes to compensated airspeed are permitted.
(Compensated airspeed = airspeed (Temp adjusted) + head/tailwind.)

3. Corrections for time require **at least 12 seconds off preflight**. Therefore, the minimum length of a speed correction is 2 minutes, except on the target leg.

4. Time corrections are always in multiples of 10 seconds.

5. For wind analysis, compare actual time to updated time; for correction, compare actual time to preflighted time.

6. Talk through your calculations to avoid making them in the wrong direction.

Timing Example 2: The time across a railroad bridge (preflight for 10+12, updated 10+02) is 9+55. Base airspeed is 150 knots, and the previous turn point time was 6+50, 10 seconds early.

FIX:
"The checkpoint was at 9+55, preflight was 10+12, resulting in 17 seconds <u>fast</u>.

ANALYZE:
The aircraft is early indicating a <u>tailwind</u>. On this leg the aircraft got 7 seconds earlier (17 seconds - 10 seconds) over a period of three minutes. Using the equations, 7 divided by 3 is approximately 2. Seconds per minute multiplied by 5 /2 equals about 5 knots of tailwind.

COMPENSATE:
Compensated airspeed is 145 knots (150-5).

CORRECT:
The aircraft is 17 seconds early. "Decrease airspeed to 130 kts (145-15) for 2 minutes and 50 seconds. Time in is 11+00. Time out is 13+50."

In the previous example, note that the wind analysis was based on time gained or lost between two points, but corrections are made on flight planned timing. At the first checkpoint there was a 10-second error so no correction was called for. However, the time to the next checkpoint or turn point was updated to reflect the 10-second deviation. Had this not been done, the wind analysis would have been for 17 seconds over 3 minutes, resulting in an estimated wind of 20 kts; well outside of the 10 kts. grading criteria!

UPDATE is a critical part of the navigation process. As the example above shows, failure to update times enroute when no correction is made leads to faulty winds. Failure to update can also cause missed checkpoints and turns.

COMPOUND WIND PROBLEMS:

The previous examples cover the skills needed for low level navigation. However, in the low level environment, cross wind and head/tail wind occur simultaneously. Analysis, compensations, corrections, and updates may become confusing as these functions interact. Students must be ready for these compound problems that are the nature of low level flight. Below is an example of such a problem:

SITUATION: The last turn point placed the aircraft 1/2 nm right of track and 8 seconds late (10+24 planned, 10+32 actual). Compensations are 4° left crab (compensated heading 176, 10kt cross wind), and a compensated airspeed of 155 (Base airspeed 150, with 5 kts. of headwind compensation). A standard course correction was performed.

FIX:
The next checkpoint shows the aircraft 1 nm. left of course. The point is abeam at 18+20, preflight was 17+48, updated to a time of 17+56.

From this information, the aircraft is 32 seconds off of preflight, and is an additional 24 seconds late after about 8 minutes of flight.

ANALYZE:
Crosswind: 1 nm over 8 minutes is the equivalent of 1/2 nm over 4 minutes, which would equate to 6 kts of wind (using the 5 minute rule). As the five-minute rule is applied to 4 minutes, the round the wind to 10 kts of *perceived* crosswind from the right.
Head/Tail wind: Over 8 minutes, 24 additional seconds late equates to 3 seconds per minute. Multiplied by 5/2 yields 7 1/2 kts, rounded to 10 kts of additional head wind.

COMPENSATE:
As soon as a wind component is resolved (real or perceived), compensate for it! Adding 4° of right crab to the current compensated heading gives a new heading of 180. Since this is flight planned heading, this indicates no cross wind. Current airspeed is 155 kts, adding ten knots the total becomes 165kts. As base airspeed is 150 kts, the wind is a 15 kt. headwind. Total wind then comes out as 180° at 15 kts.

INFORMATION SHEET 5-20

CORRECT:

Course: "Pilot, right 200°. Time in 19+09, time out 20+09" (Annotate chart)
Timing: "Airspeed 180 indicated. Time in 19+20, time out 24+40" (Annotate chart)

No update is required in the above exercise unless there is a turn or checkpoint prior to a correction being complete. Also, remember that corrections may be modified after they have been initiated.

VOICE COMMUNICATIONS

There are radio calls specific to the low-level environment. Typically, communications in the low-level environment are minimal, but getting to and from the low-level portion has several required calls.

Before beginning the VFR portion of an IFR/VFR composite flight plan, terminate the initial IFR portion. The controlling agency will terminate radar services at the final fix on the IFR leg and release the flight VFR if no action is taken. However, for mission flow and pacing, expect to cancel IFR and proceed VFR at least 30 nm prior to low-level entry (unless briefed differently by your instructor).

Terminating IFR within the PCA (Positive Control Area)

Though not likely in the T-34, if above FL 180 a descent is required before VFR flight is possible. The following procedures apply:

"**AGENCY**, **CALL SIGN**, **request descent to _______ alt to cancel IFR**."

After the controlling agency assigns an appropriate IFR altitude and local altimeter, begin the descent. Once VMC is encountered below FL180, and is maintainable to low-level entry altitude, the following transmissions apply:

" **AGENCY, CALL SIGN, CANCEL IFR**."

Note that this is a report, not a request. If VMC is not attainable by your requested altitude, request descent to "minimum vectoring altitude." If VMC is not attainable, then remain IFR and request an IFR clearance to your destination. **For T-34 VNAV flight, standard VFR visibility is required: 3 miles visibility, and 500' clear of clouds above route altitude.**

Terminating IFR below the PCA

If below the PCA, but in IMC the voice communication procedures are:

"**AGENCY**, **CALL SIGN**, **request descent to (an MSL below lower layer OR Minimum Vectoring Altitude) to cancel IFR."**

INFORMATION SHEET 5-21

After acknowledging instructions descend to the assigned altitude. If below the PCA in VMC or upon reaching VMC during descent from IMC, the following transmission applies:

"CALL SIGN, canceling IFR at this time."

ROUTE ENTRY AND TURNPOINT PROCEDURES

Route Entry

Once VFR, IMMEDIATELY take charge of the aircraft and set up for entering the low-level route. At a minimum, accomplish the following items:

1. Give the pilot **H**eading to fly.
2. Give the pilot an **A**ltitude to descend to.
3. Change **T**ransponder squawk to 1200.
4. Call FSS (ANNISTON RADIO, 255.4) to get Weather, Altimeter, and Winds for your area.
5. Change frequency to **T**actical (333.3).
6. Ensure checklists complete.

In most cases complete the Descent checklist before canceling IFR. They must be complete prior to final low-level altitude. Do not forget to report altitudes on descent.

There are two approved methods to enter the low-level route.

1. Direct. Visually extend the course line outward from the entry point to establish a point 2 1/2 nm (1 minute) prior. Maneuver to cross that point on course. If necessary, make BDHI corrections inbound to the entry point.

2. Outbound Parallel. Fly abeam the entry point at a distance equal to one turn diameter (about 4-5 nm for most aircraft). Fly the reciprocal of the first course for one minute outbound, then turn inbound. At the completion of the turn the aircraft should be on course, 1 minute prior to the entry point. Make BDHI corrections as necessary.

Route entry is the student's responsibility and either method is acceptable. In some situations a modified entry will be necessary due to time, fuel or airspace constraints. Your instructor will brief these exceptions.

Approaching the entry point, figure the temperature compensated airspeed (**MACH**), cross check the **Squawk** (1200), and give the **Clock** brief (i.e. "standby, standby, mark) prior to entering the route. For entry, pick a reference point abeam the entry point to start the clock, since the entry point will be directly under the aircraft and out of sight at entry time. Start the clock when abeam the reference point: a simple but critical step. A personal watch or clock may be used, but only in addition to (not instead of) the aircraft clock.

INSTRUCTION SHEET 5-22

LOW-LEVEL TURNPOINT PROCEDURES

Completed in the following manner without error:

2 MINUTE PRIOR CALL

1. Outbound heading ________for course_________
2. Outbound airspeed _______________
3. Recommended altitude, (MSL)
4. Description of turnpoint

MARK-ON-TOP CALL

1. Clear right/left
2. Turn right/left, (heading)
3. Time is (minutes + seconds)
4. Clear right/left

WINGS-LEVEL CALL

1. Heading is ______, for a course of ______
2. Airspeed is ______
3. Altitude is _______, Recommend ______
4. Fuel on board is ____, we are ____lbs (above/below) mission completion fuel, recommend ______. (If below MCF, compare your AFR with Bingo fuel).
5. Winds are:_____________

NOTE: If you were off course, determine why. If due to wind then use the wind formulas to determine how much wind and compensate for it. Cover the same analysis for changes in time, i.e. speeding up (more or less headwind) or slowing down (more or less tailwind).

INTERMEDIATE CHECKPOINT COMMENTARY

1. In _______________ seconds or minutes
2. There is a (brief description), (where) (L/R/on course)

INSTRUCTION SHEET 5-23

Hazard Calls

The SNFO/SNAV should at all times be on the lookout for hazards to safe flight. These hazards include other aircraft in the low altitude environment, birds, charted aerodromes and high vertical obstructions.

You are required at this stage to inform the pilot of hazards to flight following these guidelines:

1. Vertical obstructions equal to or greater than 500' MSL and within 5 nautical miles of the aircraft's flight path.
2. All aerodromes within 5 nautical miles of the aircraft's flight path.
3. All birds and aircraft.
4. Crossing/Conflicting low level routes.

For standardization purposes and for clarity of description, hazards will be described in terms of time ahead of the aircraft and in terms of distance; e.g., "In two minutes, there will be a 500' tower two miles left of course." The "bird zone" is from 11:30-12:30 on the horizon(Figure 5-18). A bird in the zone should be properly called as "Bird, right/left/on the nose, level or high."

Examples:

"In one minute, there is a 500' tower two miles left of course."

"In 45 seconds there will be a small airfield 2 nm left or course."

"Bird, 12 o'clock, high" or "Bird, on the nose, high."

"In two minutes, VNAV 3 will be crossing from right to left."

"Bird, on the nose, high."

Figure 5-18

INFORMATION SHEET 5-24

SUMMARY

This unit included all of the actual mechanics of visual low level flight. The next "step" is to put it all together in the T-34 during the actual VNAV sorties! Using the fundamental method of Fix, Analyze, Compensate, Correct, and Update, keep the aircraft on time and on course to the target.

For course corrections, if you are a known distance off course, a the standard course correction. This consists of either a 10, 20 or 30 degree change from heading held for intervals of 1 minute. However, if at an unknown distance from course with a known point (on or closer to course) in sight, a BDHI correction is ideal. Remember that BDHI corrections do not initially compensate for wind, so compensations are required afterward to maintain course.

To correct for changes in ground speed, remember that a 15 knot change (10%) corrects 6 seconds for each minute of correction. Only 15 knot adjustments are permitted, and only when at least 12 seconds off in time.

The key to successful low-level navigation is planning. The best way to ensure success is to understand the factors which affect the aircraft and to know the procedures cold. Turnpoint procedures and standard corrections should be second nature before you walk into the brief.

Here are some hints for successful completion of low-levels:

- Get the charts drawn as soon as possible! Time between your first VNAV flight and this course is deceiving! Spend the night prior "chair-flying" the mission, not drawing the chart!
- Work all of the exercise problems provided in this chapter! They will help build the math skills needed for quick and accurate computations.
- **STUDY! STUDY! STUDY!** Fly the route several times from an armchair with a stop watch running. At each checkpoint come up with a scenario (1/2 nm left of course and 5 seconds late). Practice performing track analysis and applying the appropriate compensations and corrections.
- Know the area inside each turnpoint circle well enough to describe it without reference to your chart.
- Set up a game plan. Determine beforehand how to set up the low-level route entry, where and when to start the descent, where to make required voice communications calls, when to complete checklists, etc.
- Update your charts. Take advantage of the experience you gain on your early low-levels to choose checkpoints for your later hops.
- CR-2 computers are not allowed in the low-level environment except for IAS computations.
- FIX, ANALYZE, COMPENSATE, CORRECT, UPDATE!
- CLOCK, CHART, GROUND!

ASSIGNMENT SHEET 5-1

A. Given the following information, determine appropriate wind compensations for each situation. Assume temperature compensated airspeed of 150 knots.

COURSE	WIND	WIND COMPENSATED HEADING	WIND COMPENSATED AIRSPEED
1. 001°	300°/15	_______	________
2. 127°	310°/10	_______	________
3. 232°	200°/15	_______	________
4. 095°	230°/20	_______	________
5. 338°	130°/15	_______	________
6. 053°	060°/10	_______	________
7. 185°	270°/20	_______	________
8. 269°	330°/15	_______	________
9. 118°	160°/20	_______	________
10. 358°	080°/10	_______	________
11. 151°	100°/30	_______	________
12. 163°	100°/30	_______	________
13. 294°	250°/10	_______	________
14. 306°	350°/20	_______	________
15. 197°	060°/30	_______	________
16. 072°	010°/15	_______	________
17. 276°	010°/25	_______	________
18. 143°	280°/30	_______	________

ASSIGNMENT SHEET 5-2

B. Given the following information, determine crosswind component and new compensated heading. The elapsed time shown is the time since the aircraft was last known to be on course. Assume no wind compensations during the leg duration time and 150 knots base airspeed.

	BASE COURSE	ELAPSED TIME	DISTANCE (NM) OFF COURSE	CROSSWIND AIRSPEED	NEW COMPENSATED HEADING
1.	335°	3+00	1/2 Right	________	________
2	017°	3+00	1 Left	________	________
3.	121°	6+00	1-1/2 Right	________	________
4.	242°	6+00	3 Left	________	________
5.	080°	9+00	3 Right	________	________
6.	352°	9+00	1-1/2 Left	________	________
7.	209°	4+00	2 Right	________	________
8.	154°	4+00	1 Left	________	________
9.	286°	5+00	2 Right	________	________
10.	233°	8+00	2 Left	________	________
11.	299°	8+00	1-1/2 Right	________	________
12.	318°	4+30	1-1/2 Left	________	________

ASSIGNMENT SHEET 5-3

C. Given the following information, determine the winds and a new compensated heading and/or airspeed. "Time" is the elapsed time since the aircraft was last on course and mission planned timing. Assume that base heading was maintained for the elapsed time, and airspeed was a constant 150 KTAS, 150 KIAS (150 kts ground speed desired).

	ETA	ATA	Dist. Off Course	TIME	CUS	W/V	Comp. HDG	Comp. KIAS
1.	6+06	6+24	1-1/2L (L=Left, R=Right)	6+00	189°	260/20	195°	160
2.	7+12	6+42	2-1/2 L	10+00	327°	_____	_____	_____
3.	8+18	8+30	1 R	4+00	001°	_____	_____	_____
4.	11+13	11+48	1/2 R	6+00	234°	_____	_____	_____
5.	12+42	12+28	2-1/2 L	7+00	358°	_____	_____	_____
6.	13+48	13+58	NONE	10+00	176°	_____	_____	_____
7.	14+54	14+32	2 R	5+30	283°	_____	_____	_____
8.	16+00	16+25	1 L	6+15	049°	_____	_____	_____
9.	16+02	15+47	2-1/2 L	5+00	314°	_____	_____	_____
10.	17+24	17+48	2 R	6+00	018°	_____	_____	_____
11.	18+36	18+13	NONE	5+45	065°	_____	_____	_____
12.	20+30	20+45	2-1/2 R	7+30	346°	_____	_____	_____

D. Given the following information determine appropriate standard course corrections for each situation. Assume no wind conditions, base airspeed of 150 knots and at least six minutes remaining on the leg.

BASE HEADING	DISTANCE (NM) OFF COURSE	MARK TO HEADING	CORRECTION DURATION
1. 012°	2 Right	_______	__________
2. 327°	1.5 Left	_______	__________
3. 154°	1 Right	_______	__________
4. 225°	2 Left	_______	__________
5. 349°	3 Left	_______	__________
6. 164°	0.5 Right	_______	__________
7. 048°	1 Left	_______	__________
8. 273°	2.5 Right	_______	__________
9. 021°	2 Right	_______	__________
10. 103°	1.5 Right	_______	__________
11. 301°	2 Left	_______	__________
12. 213°	4 Left	_______	__________
13. 359°	2.5 Left	_______	__________
14. 017°	3 Right	_______	__________
15. 080°	0.5 Left	_______	__________

ASSIGNMENT SHEET 5-5

E. Given the following information determine appropriate standard time correction for each situation. Assume no wind conditions and base airspeed of 150 knots.

PREFLT TIME OF ARRIVAL	ACTUAL TIME OF ARRIVAL	RECOMMENDED AIRSPEED	CORRECTION DURATION
1. 8+54	9+06	_______	__________
2. 12+12	11+54	_______	__________
3. 3+36	3+24	_______	__________
4. 5+48	5+24	_______	__________
5. 7+42	8+00	_______	__________
6. 10+00	10+15	_______	__________
7. 13+06	13+15	_______	__________
8. 17+30	17+09	_______	__________
9. 21+36	21+51	_______	__________
10. 16+24	16+03	_______	__________
11. 19+12	19+32	_______	__________
12. 23+54	24+22	_______	__________
13. 25+06	24+56	_______	__________
14. 29+18	29+01	_______	__________
15. 6+42	6+55	_______	__________
16. 15+48	16+19	_______	__________
17. 31+00	30+13	_______	__________
18. 18+12	17+39	_______	__________

ASSIGNMENT SHEET 5-6

F. Given the following information determine appropriate standard speed correction and the time the correction should be taken out. Assume no wind conditions and base airspeed of 150 knots.

PREFLT TIME OF ARRIVAL	ACTUAL TIME OF ARRIVAL	TIME IN	RECOMMENDED AIRSPEED	TIME OUT
1. 5+12	5+26	5+50	_______	__________
2. 6+48	6+23	6+25	_______	__________
3. 7+48	8+07	8+20	_______	__________
4. 8+12	8+35	8+35	_______	__________
5. 9+12	9+39	10+00	_______	__________
6. 10+48	10+28	10+40	_______	__________
7. 11+36	11+25	11+40	_______	__________
8. 12+24	13+05	13+20	_______	__________
9. 13+36	13+57	14+20	_______	__________
10. 14+24	14+07	14+30	_______	__________
11. 15+00	15+53	16+25	_______	__________
12. 16+12	16+00	16+35	_______	__________
13. 17+48	18+45	19+15	_______	__________
14. 19+36	19+17	19+45	_______	__________
15. 19+48	19+31	18+55	_______	__________

Answers to Assignment Exercises

UNIT-1: ASSIGNMENT ANSWERS

1. LAMBERT CONFORMAL

2. 1:5,000,000
   1:1,000,000
   1:500,000
   1:2,000,000

3.
   - STRAIGHT LINE APPROXIMATES A GREAT CIRCLE.
   - SCALE ABOUT A POINT IS THE SAME IN ALL DIRECTIONS.
   - ANGLES ARE CORRECTLY REPRESENTED AND SMALL SHAPES ARE PROPORTIONAL.

4.
   - SIZE OF AREA TO BE CHARTED
   - AMOUNT OF DETAIL TO BE SHOWN.

5. SMALLER

6. HARD
   3,000'

7. FLAT OR RELATIVELY LEVEL TERRAIN

8.
   a. VOR
   b. VORTAC
   c. TACAN
   d. VOR DME

9.
   a. FLIP
   b. CHUM
   c. NOTAMS

10.
   - 700'
   - 1,100'

11. 500'

12. 600'

13.
   - 6,000'
   - 636'

14.
   - WARNING
   - AP/1A

15.
   - 8,000'

Answers to Assignment Exercises

UNIT-2: ASSIGNMENT ANSWERS

1.
   - AP/1B
   - NOTAMS
   - CHUM

2. 500' AGL

3. 20 NM

4. 1:500,000

5. 5 NM SQUARE

6. FALSE

7. 35

8. 066º

9.
   - inbound
   - inbound

10. 7

UNIT-3: ASSIGNMENT ANSWERS

1. VERTICAL

2. HORIZONTAL

3. FIX

4. SPEED / TIME

5. 2; 1 ½

6.
   - CLOCK
   - CHART
   - GROUND

7. HORIZONTAL

8. 1 NM

9. TRAFFIC; TRUCKS

10. 6 TO 8 INTERMEDIATE

Answers to Assignment Exercises

ABOVE THIS LINE DATA IS CORRECT

---

1. TO DETERMINE TRENDS OR MALFUNCTIONS IN FLIGHT.

2. FUEL NEEDED AT EACH TURNPOINT TO COMPLETE THE PLANNED MISSION AND ARRIVE AT THE IAF WITH COMMAND DIRECTIVE MINIMUMS.

3. THE DIFFERENCE OF SOP MINIMUMS AND PLANNED FUEL AT THE IAF, APPLIED EITHER + OR - TO EFR AT EACH TURNPOINT.

4. FUEL REQUIRED TO SAFELY EXECUTE MISSION ABORT FROM EACH TURNPOINT TO HOMEPLATE.

5. FUEL, HEADING AND ALTITUDE

6. MCF = 520#

   EFR = 570#
   MCF = 495#

   EFR = 515#
   MCF = 440#

STUDENT GUIDE
VISUAL NAVIGATION

UNIT-10: ASSIGNMENT SHEET ANSWERS

UNIT-4: ASSIGNMENT ANSWERS

A.

1.	357	155
2.	127	140
3.	230	160
4.	101	135
5.	340	140
6.	053	160
7.	193	150
8.	273	155
9.	124	165
10.	002	150
11.	143	170
12.	155	165
13.	292	155
14.	312	165
15.	189	130
16.	068	155
17.	286	150
18.	151	130
19.	023	175
20.	201	145

B.

1.	10	331	
2.	20	025	
3.	15	115	
4.	30	254	
5.	20	076	
6.	10	356	
7.	30	197	
8.	15	160	
9.	25	276	
10.	15	239	
11.	10	295	
		OR	
	15		293
12.	20		326

D.

E.

Answers to Assignment Exercises

1.	002	4+00	1.	165	2+00	1.	165	8+10
2.	337	3+00	2.	135	3+00	2.	135	10+35
3.	144	2+00	3.	135	2+00	3.	165	11+30
4.	235	4+00	4.	135	4+00	4.	165	12+25
5.	009	3+00	5.	165	3+00	5.	165	14+30
6.	154	1+00	6.	165	2+30	6.	135	14+00
7.	058	2+00	7.	N/A	N/A	7.	N/A	N/A
8.	263	5+00	8.	135	3+30	8.	165	20+10
9.	011	4+00	9.	165	2+30	9.	165	17+50
10.	093	3+00	10.	135	3+30	10.	135	17+20
11.	311	4+00	11.	165	3+20	11.	165	25+15
12.	233	4+00	12.	165	4+40	12.	135	18+35
13.	009	5+00	13.	N/A	N/A	13.	165	28+45
14.	357	3+00	14.	135	2+50	14.	135	22+55
15.	090	1+00	15.	165	2+10	15.	135	21+45
			16.	165	5+10			
			17.	135	7+50			
			18.	135	5+30			

19. 135 4+10 20. 165 8+20

EFR AT IAF = 2050 BINGO A

STUDENT GUIDE
VISUAL NAVIGATION

UNIT-10: ASSIGNMENT SHEET ANSWERS

UNIT-5: ASSIGNMENT ANSWERS

VR-1000	VR-2000
7+18	5+24
8+12	6+18
4+24	8+24
5+06	4+06

TOTAL ETE VR-1000 = 25+00
TOTAL ETE VR-2000 = 24+12

FF AT 10K = 1300 PPH
ETE AT 10K = 18.5

4340	3280	2990	1930
4120	3110	2770	1760
3870	2920	2520	1570
3740	2660	2390	1310
3580	2530	2230	1180

A.

1.	359	305	
Left	333		
2.	127	290	
Right	021		
3.	231	310	
Left	118		
4.	098	285	
Right	248		
5.	339	290	
Left	106		
6.	054	310	
Right	354		
7.	189	300	
Left	203		
8.	271	305	
Right	157		
9.	121	315	
Left	281		
10.	362	300	
Right	236		
11.	147	320	
Left	297		

B.

1.	10 kts,
2.	20 kts,
3.	15 kts,
4.	30 kts,
5.	20 kts,
6.	10 kts,
7.	30 kts,
8.	15 kts,
9.	25 kts,
10.	15 kts,
11.	10 kts,

1.	234/22	192
2.	102/22	330
3.	316/22	358
4.	220/15	233
5.	118/25	002
6.	176/05	176
7.	148/30	279
8.	079/25	051
9.	074/37	320
10.	333/30	014
11.	245/20	065

Answers to Assignment Exercises

12. 157 310 12. 20 kts, 2. 346 330 8.
Right 322 12. 286/25 342 310 3. 7:00 12KTS 9.
13. 293 305 4. 181 BH 300-305 BA/S 10.
14. 309 315 191 FOR 2+00 NO SPED CORR 11.
15. 193 280 5. ON COURSE ON TIME 12.
16. 070 305 6. 2:30 TO 3:00 AT 30 KTS 13. 048-
17. 281 300
18. 147 280
19. 025 325
20. 202 295

D.			E.			F.		
1.	002	2+00	1.	330	2+00	1.	330	8+10
2.	337	1+30	2.	270	3+00	2.	270	10+35
3.	144	1+00	3.	270	2+00	3.	330	11+30
4.	235	2+00	4.	270	4+00	4.	330	12+25
5.	359	3+00	5.	330	3+00	5.	330	14+30
6.	154	0+30	6.	330	2+30	6.	270	14+00
7.	058	1+00	7.	N/A	N/A	7.	N/A	N/A
8.	263	2+30	8.	270	3+30	8.	330	20+10
9.	011	2+00	9.	330	2+30	9.	330	17+50
10.	093	1+30	10.	270	3+30	10.	270	17+20
11.	311	2+00	11.	330	3+20	11.	330	25+15
12.	233	4+00	12.	330	4+40	12.	270	18+35
13.	009	2+30	13.	N/A	N/A	13.	330	28+45
14.	007	3+00	14.	270	2+50	14.	270	22+55
15.	090	0+30	15.	330	2+10	15.	270	21+45
			16.	330	5+10			
			17.	270	7+50			
			18.	270	5+30			
			19.	270	4+10			
			20.	330	8+20			

STUDENT GUIDE
VISUAL NAVIGATION

G.
1. 267 285 7. 277-278/290-285 14. 303 270